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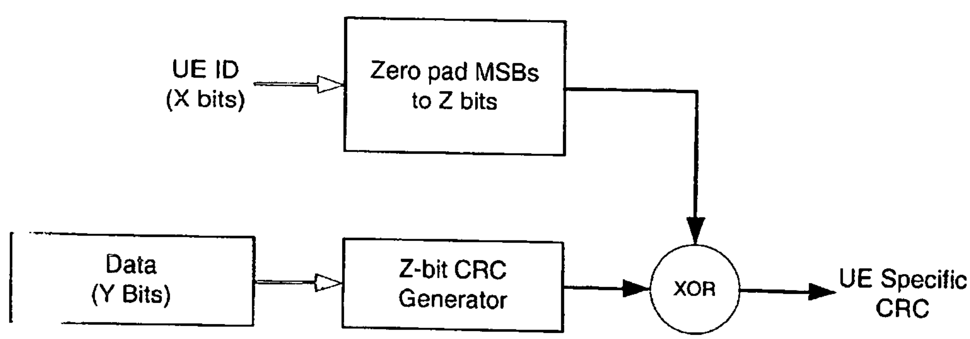
(54) Title: GENERATION OF A BLOCK CODED TERMINAL IDENTIFIER



(57) Abstract: A user equipment (UE) specific scrambling code can be used for the purposes of implicitly identifying the intended UE for a transmission on a shared channel (i.e. no explicit UE identifier is transmitted). This is achieved by scrambling a known or derivable data sequence that must be transmitted anyway, such as a cyclic redundancy code (CRC). It is proposed that this scrambling code be generated by block coding the UE identifier such that the set of scrambling codes has good minimum distance properties for the set of UE identifiers. The proposed technique is to use a set of basis sequence to generate the code. Basis sequences sets exist that will give good minimum distance properties independent of the size of the UE identifier. By using one of these sets, the probability that an unintended UE will incorrectly believe a message on the shared channel to be intended for it can be reduced when compared to existing techniques, such as zero-padding the UE identifier.

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GENERATION OF A BLOCK CODED TERMINAL IDENTIFIER

The present invention relates to improvements in or relating to mobile terminal identification. In particular the present invention relates to an apparatus and a method for addressing a digital data message to a recipient device using block coded scrambling codes, thereby providing implicit mobile terminal identification.

A scrambling code specific to a given user equipment (UE) can be used for the purposes of implicitly identifying the intended UE for a transmission on a shared channel: no explicit UE identifier need be transmitted. Implicit identification is achieved by scrambling a known or derivable data sequence that must be transmitted anyway. One suitable sequence would be an error checking sequence.

As is well known in the art, the term user equipment refers generally to a class of user devices which operate within a telecommunications network and which are distinct from base stations. An important example of a UE is a mobile telephone handset.

Error checking seeks to ensure the accuracy of transmission of digital data. One commonly used error checking technique is CRC (Cyclical Redundancy Checking). In CRC, the transmitted messages are divided into blocks of a predetermined number of bits. A fixed (known) polynomial operates upon each message block. The result of the operation, known as the cyclical redundancy code, is appended onto and sent with each message block as check data. The device receiving the message performs the same calculation for each message block received so that the

remainder is recalculated. If the locally calculated CR code does not match the transmitted CR code, an error is detected.

In 2002-03 release of the UTRA system, the address of the recipient UE is carried implicitly by scrambling the CR code with a UE specific scrambling code. This scrambling code is generated by zero-padding the UE identifier to the predetermined length of a CR code, (generally either 16 bits or 32 bits).

The zero-padding scrambling technique can potentially lead to incorrect identification where there are unfavourable minimum distance properties for the set of UE identifiers. Although an erroneous message on a shared channel will be rejected by the intended recipient, there is an ever-present possibility that the error could lead to the identification of a different and unintended, yet valid, recipient. The minimum "distance" between UE identifiers can be calculated from the number of bits whose values must change when switching from one identifier to the next.

It is therefore an object of the invention to obviate or at least mitigate the aforementioned problems.

Advantageously, scrambling code for implicit identification of a given UE may be generated by block coding a unique identifier such that the set of scrambling codes has good minimum distance properties for the set of UE identifiers.

In accordance with one aspect of the present invention, there is provided a method for addressing, to a selected recipient device having associated therewith a unique identifier, a message for transmission over a telecommunications network supporting communication with many recipient devices; the method comprising the steps of:

providing an error check portion for inclusion in the message;

block-coding the unique identifier; and

combining the error check portion and the block-coded unique identifier,

thereby generating for said message a coded inclusion implicitly indicative of the unique identity of said selected recipient device.

Preferably, said error check portion comprises a code derived from the message and, in one embodiment, such a code comprises a cyclical redundancy code derived by performing the step of cyclical redundancy checking on said message.

It is preferred that, in circumstances where said error check portion comprises a code of Z-bits in length and said unique identifier comprises a code of X bits in length; said block coding step is performed on said unique identifier by means of a (Z, X) block code conforming, for example, to Reed-Muller criteria.

Conveniently and preferably, the step of combining the error check portion and the block-coded unique identifier is implemented by means of an exclusive OR operation.

The invention also provides, from another aspect, a communications network comprising means configured to implement the methods described in any of the preceding paragraphs for addressing, to a selected recipient device having associated therewith a unique identifier, a message for transmission over the network.

For a better understanding of the present invention, reference will now be made, by way of example only, to the accompanying drawings in which:-

Figure 1 shows the method for generating scrambling code adopted in the 2002-03 release of the current UTRA standard; and

Figure 2 shows a method for generating scrambling code in accordance with the present invention.

The address of the recipient UE for a Shared Control Channel for HS-DSCH (HS-SCCH) transmission can be carried implicitly by scrambling the CR code with a UE specific scrambling code. In the 2002-03 release of the UTRA system, this scrambling code is generated by zero-padding the UE identifier to the length of a CR code.

Note that the abbreviation UTRA denotes UMTS Terrestrial Radio Access, where UMTS stands for Universal Mobile Telecommunications System.

The standard scrambling process is shown in Figure 1. Where each CR code is Z bits in length, the (X bit long) unique identifier for each UE is zero-padded. In Figure 1, the zero-padding is applied to the most significant bits (MSB). The zero-padded identifier is now Z bits long.

The data of each message is Y bits in length. Y may be greater than, less than or equal to the predetermined length of a CR code. A CR code is generated from the message by a CRC generator.

The CR code and the zero-padded identifier are combined. In Figure 1, the combining function is a bitwise exclusive-OR (XOR) operation. The combined output is thus a CR code which has been scrambled for the receipt by a specific UE.

If there are no channel errors, then this scheme works adequately for both the intended and unintended UEs. If a CR code computed for the received data matches the unscrambled transmitted CR code, then the UE can be reasonably certain that the message is intended for it. If on the other hand, the two do not match, then the UE can assume that either the message was intended for it, but has been corrupted by errors, or that the message was not intended for it. In both cases, the UE should not attempt to decode the message.

In the presence of channel errors, however, the possibility that an unintended UE believes that it is the intended UE must be considered. This could happen because errors in the message data change the computed CR code in the UE, or because errors in the received CR code itself change the effective scrambling code used (or a combination of both these errors).

If all error combinations were equally likely, then the probability of a HS-SCCH (shared channel) transmission appearing to have a valid scrambling code for a user equipment other than the originally intended UE is 1 in $2^{(Z-X)}$, and is independent of the method used to generate the scrambling code (provided each scrambling code is unique). However, in practice, all error combinations will not be equally likely due to the nature of the channel and the convolutional decoding procedure, and hence the method of generating the scrambling code will have an effect on the probability of reception by an unintended UE.

The proposed technique is to use a set of basis sequences to generate the code. Basis sequences sets exist that will give good minimum distance properties independent of the size of the UE identifier. By using one of these sets, the probability that an unintended UE will incorrectly believe a message on the shared channel to be intended for it can be reduced when compared to existing techniques, such as zero-padding the UE identifier.

In a preferred embodiment, the scrambling code is generated using a (Z, X) block code. This code is constructed as follows:

$$z_i = (A_{0,i} \cdot x_0) \oplus (A_{1,i} \cdot x_1) \oplus \ldots \oplus (A_{X-1,i} \cdot x_{X-1})$$

for all i = 0 .. Z-1,

where $\{z_i : i = 0 .. Z\text{-}1\}$ is the Z-bit scrambling code;

$\{x_j : j = 0 .. X\text{-}1; X \leq Z\}$ is the X-bit UE identifier;

$\{A_j : j = 0 .. X\text{-}1\}$ is a set of X basis sequences of Z bits each;

$\{A_{j,i} : i = 0 .. Z\text{-}1\}$ is the set of bits of basis sequence A_j;

$\oplus$ is the exclusive-OR operator; and

$\cdot$ is the AND operator.

The method is illustrated in Figure 2. Again each CR code is Z bits in length and the unique identifier for each UE is X bits in length. The block code described above results in a coded identifier that is Z bits long.

As in the conventional method, a CR code is generated from the message by a CRC generator.

The CR code and the coded identifier are combined. As before, the combining function is a bitwise exclusive-OR (XOR) operation. The combined output is thus a CR code which has been scrambled for the receipt by a specific UE.

In a preferred embodiment the block coding technique applied uses Reed-Muller code. Reed-Muller code gives near-optimum minimum distance properties irrespective of the actual value of X. The use of Reed-Muller codes does however require that Z is a power of 2. However, as is known in the art, the code can be "punctured" even where Z is not a power of 2.

The decoding of Reed-Muller encoded messages relies on the minimum distance properties between UE identifiers. Reed-Muller codes are distributed evenly amongst the possible Z bit long sequences thereby maintaining the maximum distance between codes. Even in the presence of errors, Reed-Muller codes allow a decoder to assume that the message was encoded according to the closest (most similar) Reed-Muller codeword.

It will be understood that the generation of scrambling code is not limited to UEs. Certainly scrambling codes may be generated by UEs that have an appropriate set of basis functions. It is also possible that

scrambling codes may be generated elsewhere on the network and signalled directly to the UE over the network.

Although the preceding discussion is concerned with specific sets of basis functions it will be understood that basis functions for use in the block code method may be selected in a great many different ways. The present invention is not intended to be limited to the sets of basis functions given in illustrative examples; indeed any sets of X basis functions of Z bits length can be adopted.

CLAIMS:

1. A method for addressing, to a selected recipient device having associated therewith a unique identifier, a message for transmission over a telecommunications network supporting communication with many recipient devices; the method comprising the steps of:

providing an error check portion for inclusion in the message;

block-coding the unique identifier; and

combining the error check portion and the block-coded unique identifier,

thereby generating for said message a coded inclusion implicitly indicative of the unique identity of said selected recipient device.

2. A method according to claim 1 wherein said error check portion comprises a code derived from the message.

3. A method according to claim 2 wherein the code comprises a cyclical redundancy code derived by performing the step of cyclical redundancy checking on said message.

4. A method according to any preceding claim wherein said error check portion comprises a code of Z-bits in length and said unique identifier comprises a code of X bits in length; and wherein said block coding step is performed on said unique identifier by means of a (Z, X) block code.

5. A method according to claim 4 wherein said block-coding step is performed in accordance with a Reed-Muller code.

6. A method according to any preceding claim wherein said step of combining the error check portion and the block-coded unique identifier is implemented by means of an exclusive OR operation.

7. A method for addressing, to a selected recipient device having associated therewith a unique identifier, a message for transmission over a telecommunications network supporting communication with many recipient devices; the method being substantially as herein described with reference to and/or as shown in Figure 2 of the accompanying drawings.

8. A communications network comprising means configured to implement a method, according to any preceding claim, for addressing, to a selected recipient device having associated therewith a unique identifier, a message for transmission over the network.

9. An apparatus for addressing, to a selected recipient device having associated therewith a unique identifier, a message for transmission over a telecommunications network supporting communication with many recipient devices; the apparatus comprising:

means for providing an error check portion for inclusion in the message;

means for block-coding the unique identifier; and

means for combining the error check portion and the block-coded unique

identifier,

thereby generating for said message a coded inclusion implicitly indicative of the unique identity of said selected recipient device.

10. An apparatus according to claim 9 wherein said error check portion comprises a code derived from the message.

11. An apparatus according to claim 10 wherein the code comprises a cyclical redundancy code derived by performing the step of cyclical redundancy checking on said message.

12. An apparatus according to any preceding claim wherein said error check portion comprises a code of Z-bits in length and said unique identifier comprises a code of X bits in length; and wherein said block coding step is performed on said unique identifier by means of a (Z, X) block code.

13. An apparatus according to claim 12 wherein said block-coding step is performed in accordance with a Reed-Muller code.

14. An apparatus according to any preceding claim wherein said step of combining the error check portion and the block-coded unique identifier is implemented by means of an exclusive OR operation.

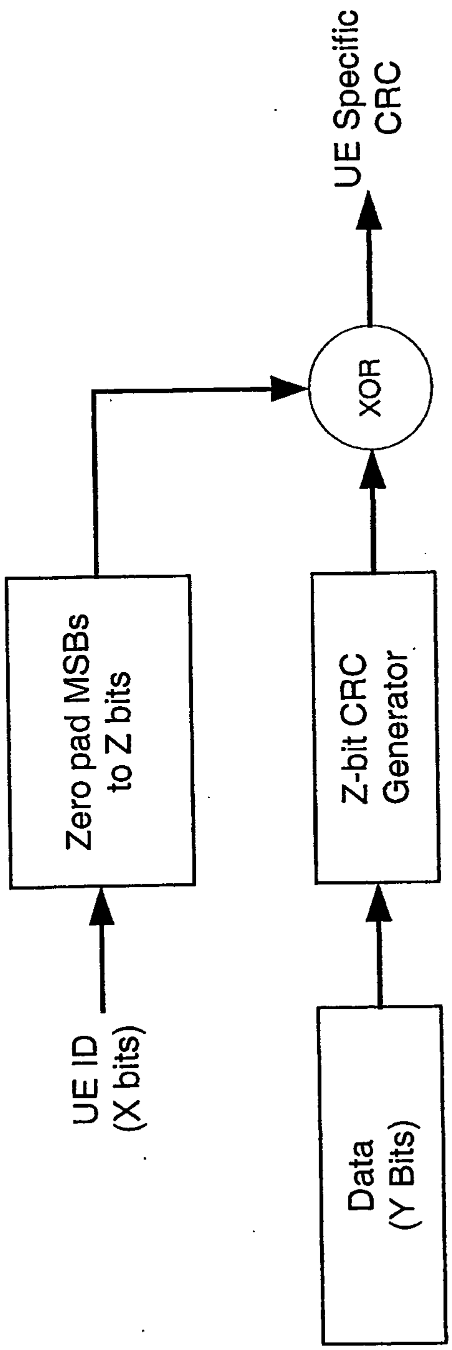
UE ID
(X bits)
Zero pad MSBs
to Z bits
Data
(Y Bits)
Z-bit CRC
Generator
XOR
UE Specific
CRC

Fig 1

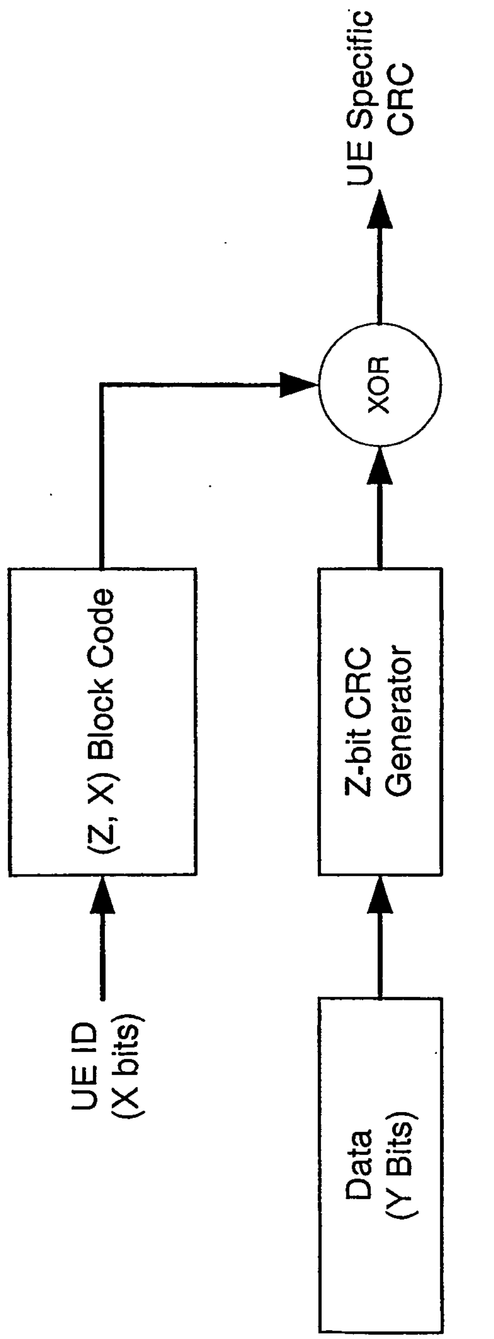
UE ID
(X bits)
(Z, X) Block Code
Data
(Y Bits)
Z-bit CRC
Generator
XOR
UE Specific
CRC

Fig 2

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 03/03405

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04L1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04L H03M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 142 539 A (DAHLIN JAN E AANGSTROEM ET AL) 25 August 1992 (1992-08-25) column 3, line 12 - line 21 column 3, line 45 - line 54 column 4, line 15 - line 38; figure 4 ---	1-3, 6-11,14
Y	US 6 201 811 B1 (LARSSON PETER ET AL) 13 March 2001 (2001-03-13) column 2, line 27 - line 39 column 5, line 47 - line 56 column 6, line 35 - line 60 column 7, line 20 - line 57; figure 3 column 5, line 47 - line 56 column 6, line 35 - line 60 --- -/--	1-14

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
28 July 2003	05/08/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Papantoniou, A

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 03/03405

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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